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Leucoagaricus orientiflavus, a new yellow lepiotoid species from southwestern China

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Abstract — *Leucoagaricus orientiflavus* is described as new from southwestern China. It is characterized by a yellow pileus lacking plicate striations toward the margin, pure white lamellae, yellowish stipe and context, subamygdaliform basidiospores that are dextrinoid and lack a germ pore, cylindrico-clavate cheilocystidia, and a cutis-type pileipellis made up of radially arranged subcylindrical hyphae.

Key words — *Agaricales*, lepiotaceous fungi, morphology, systematics, taxonomy

Introduction

The genus *Leucoagaricus* Locq. ex Singer (*Agaricaceae*, *Agaricales*, *Basidiomycota*) is regarded to be a genus intermediate between the genera *Macrolepiota* Singer and *Leucocoprinus* Pat. Morphologically, species within *Leucoagaricus* can be recognized by the following combination of characters: surface of the pileus scaly-excoriated or even, fibrillose, pubescent or glabrous, not sulcate or sulcate only at the margin; spore print white, cream to pink; spores usually less than 10 µm, dextrinoid, metachromatic in cresyl blue; hymenium without conspicuous pseudoparaphyses; and hyphae in the trama of the pileus and stipe without clamp connections. *Leucoagaricus* differs from *Macrolepiota* by having relatively slender basidiomata and in lacking clamp connections in the trama of the pileus and stipe. *Leucoagaricus* can be distinguished from *Leucocoprinus* because *Leucocoprinus* has notable striations on the pileus, pseudoparaphyses in the hymenium, and spores that usually have a germ pore (Singer 1986). *Leucoagaricus* has received much attention in recent years worldwide (Akers et al. 2000; Akers & Ovrebo 2005; Didukh et al. 2003; Hausknecht & Pidlich-Aigner 2004; Kumar & Manimohan 2009; Ortiz et al. 2008; Rother & da Silveira

2009; Vellinga 2000, 2004, 2007; Vellinga & Davis 2007; Wasser 1993), and a few new species have been described. In this paper a newly discovered yellow species of *Leucoagaricus* from southwestern China is described.

Materials and methods

The examined materials were collected in Kunming (southwestern China, Asia), and deposited in the Herbarium of Cryptogams, Kunming Institute of Botany, Chinese Academy of Sciences (HKAS/KUN). Macroscopic characters were examined on fresh basidiomata. Color notations indicated in the description are from Kornerup & Wanscher (1978). Micromorphology is based on observation of the material under a light microscope at 1000×. Tissues were sectioned by hand and mounted in 5% KOH, and pileal structure, cheilocystidia, basidia, and basidiospores were observed. KOH mounts were then stained with Congo Red for the preparation of line drawings. Melzer's reagent was used to test the amyloidy of spores, and spore wall reactions were checked in Cresyl Blue and Cotton Blue. At least 20 basidiospores were measured for each collection; the notation [60/3/2] indicates 60 spores measured from 3 fruit bodies in 2 collections. Dimensions for basidiospores are given using notation of form (a–)b–c(–d), with b–c containing a minimum of 90% of all values measured. Extreme values (a and d) are given in parentheses. Q indicates length/width ratio of a spore measured in side view with avQ denoting the average Q of all basidiospores ± sample standard deviation. nrITS sequences generated for the collections are deposited in GenBank and listed with the collections.

Taxonomy

Leucoagaricus orientiflavus Z.W. Ge, **sp. nov.** Figure 1

MycoBank MB 515274; GenBank nrITS GU084262

Pileus 30–80 mm latus, primo ovoideus, deinde convexus et convexo-applanatus, glaber, raro rugulosus, luteolus, pallide flavus vel flavus. Lamellae liberae, albae, confertae. Stipes 50–105 × 6–13 mm, subflavus vel flavo-albidus. Sporae (6.0–)6.5–7.5 × (3.0–)3.5–4.0 µm, amygdaliformiae. Basidia 17–24 × 6–7.5 µm, clavata, 4-sporigera. Acies lamellarum sterilis. Cheilocystidia 28–43 × 9.0–11.0 µm, cylindrico-clavata vel anguste clavata. Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Squamulae pilei ex epicute e hyphis repentibus, subcylindricis compositae. Caro flavo-albida. Fibulae abscentes. Habitatio: terrestris.

Holotypus: China, Yunnan Province, Kunming, Heilongtan: 22 July 2008, Z.W. Ge 2063 (HKAS 54260) (GenBank nrITS GU084262).

Etymology: *orienti-* refers to the type locality and *-flavus* refers to the color of this fungus.

Basidiomata (Fig. 1a) medium sized. Pileus 30–80 mm in diam., ovoid when young, becoming convex to broadly convex and finally plano-convex, without an umbo; surface dry, slightly viscid when wet, pastel yellow (2A4), light yellow (2A5), yellow (2A6–2A7) to vivid yellow (2A8); yellowish white (2A2) towards margin, smooth, occasionally somewhat rugose; margin entire to slightly

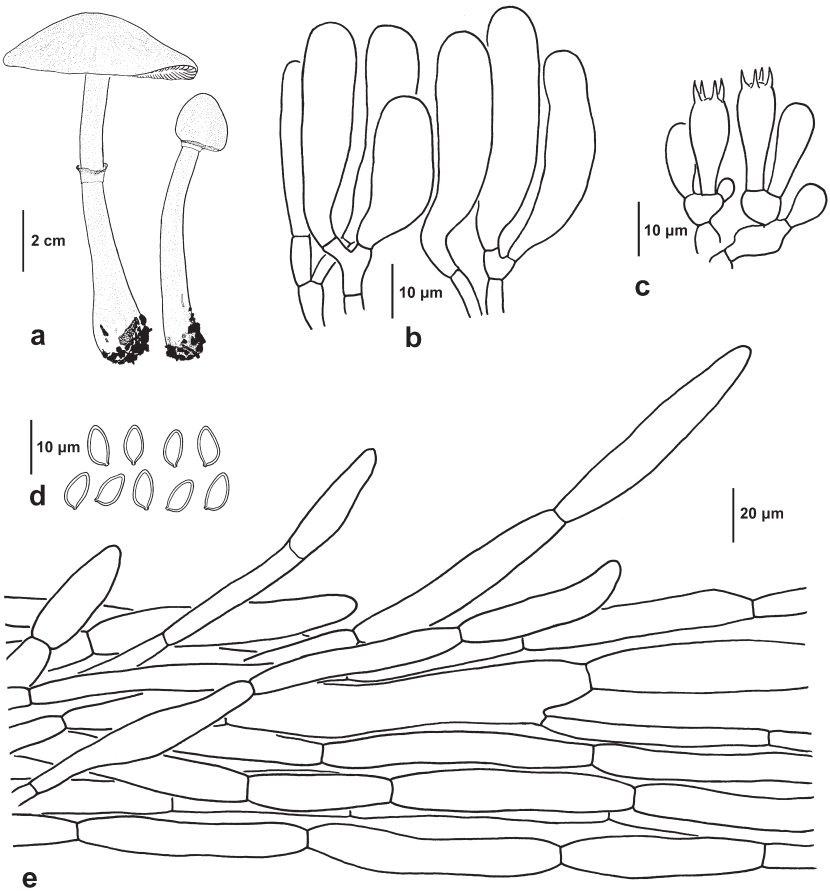

Fig. 1. *Leucoagaricus orientiflavus* (holotype).
a. Basidiomata; b. Cheilocystidia; c. Basidia; d. Basidiospores; e. Pileus covering.

crenate. Lamellae free, remote from the stipe, pure white, close to crowded, up to 7 mm wide, with lamellulae in 2–3 tiers; edge even to naked eye, fimbriate under a lens, concolorous with the faces. Stipe cylindrical, 50–105 × 6–13 mm, central, slightly expanded towards the base (up to 13 mm wide), solid when young, becoming fistulose and finally hollow with age; surface yellowish to yellowish white, smooth, somewhat fibrillose under lens. Annulus median, membranous, soft, persistent, yellowish white, fixed. Context thin, yellowish white (2A2) to yellow (2A6) in both pileus and stipe, up to 4 mm thick in pileus. Odor not distinctive. Spore print white.

Basidiospores (Fig. 1d) [60/3/2] (6.0–)6.5–7.5 × (3.0–)3.5–4.0 μm, Q = 1.63–1.88 (2.17), avQ = 1.84 ± 0.156, amygdaliform in side view, narrowly ovoid in frontal view, hyaline, with refractive guttules, slightly thick-walled, smooth, without germ pore, dextrinoid, metachromatic in Cresyl Blue, cyanophilous in Cotton Blue. Subhymenium composed of irregularly inflated cellular hyphae. Basidia (Fig. 1c) 17–24 × 6–7.5 μm, clavate, hyaline, with guttulate contents, bearing 4 sterigmata up to 3 μm long. Pseudoparaphyses not observed. Cheilocystidia (Fig. 1b) abundant, forming a sterile edge, 28–43 × 9.0–11.0 μm, cylindrico-clavate to narrowly clavate, occasionally with a median constriction, hyaline, thin-walled. Pleurocystidia absent. Lamellar trama subregular; hyphae 4–8 μm, hyaline, thin-walled, often pale yellowish walled. Pileus covering (Fig. 1e) a cutis of appressed, radially arranged subcylindrical hyphae sometimes branched, with elements measuring (50–)85–115 × (8–)11–15 (–17) μm, thin-walled, hyaline to pale yellow, occasionally disrupted by ascending, more or less pointed terminal elements, without globose elements. Pileal trama interwoven; hyphae 8–22 μm wide, cylindrical, septate, hyaline, thin-walled to slightly thick-walled. Stipe covering similar to pileal covering, composed of a cutis of loosely arranged cylindrical hyphae around 7–10(–18) μm wide, hyaline to pale yellowish, slightly thick-walled. Clamp Connections not observed in any hypha examined.

Habitat and Distribution: Saprotrophic and terrestrial on clayey soils, scattered or in small groups, not in clusters. So far only known from the type locality, Kunming, Yunnan province, China.

Additional collections examined — CHINA, Yunnan Province, Kunming, Kunming Botanical Garden: 25 July 2008, *Z.W. Ge 2068* (*HKAS 54265*) (GenBank nrITS GU084261).

Comments: *Leucoagaricus orientiflavus* is clearly delimited by a unique combination of characters. Macroscopically, it has a yellow pileus that lacks marginal striations, pure white lamellae, a yellowish stipe, and yellowish to yellow context. Microscopically, it bears dextrinoid amygdaliform spores without a germ pore, cylindrico-clavate to narrowly clavate cheilocystidia, a cutis-type pileal covering composed of appressed, radially arranged subcylindrical hyphae, and lacks clamp connections.

Infrageneric classifications of *Leucoagaricus* are not consistent. Singer (1986) recognized six sections within this genus and regarded *Sericeomyces* Heinem. as a separate genus. Bon (1981) regarded *Sericeomyces* as a subgenus within *Leucoagaricus,* a classification now accepted by most mycologists (e.g., Candusso & Lanzoni 1990, Vellinga 2000).

ITS sequence data (Z.W. Ge, unpublished data) show *Leucoagaricus orientiflavus* as phylogenetically closely related to *La. serenus* (Fr.) Bon & Boiffard, the type species of subgenus *Sericeomyces*. *Leucoagaricus orientiflavus*

and *La. serenus* share similar microscopic characters, including a pileal cutis of subcylindric repent hyphae and amygdaliform spores. However, *La. orientiflavus* is easily distinguished from the white *La. serenus* by its yellow pileus and stipe as well as by its cylindrico-clavate to narrowly clavate cheilocystidia (Candusso & Lanzoni 1990, Vellinga 2000).

Leucoagaricus medioflavoides Bon, another closely related species, differs in having a much smaller (1–2 cm), a paler pileus that is yellowish only near the center, smaller (5–6 × 3.0–3.5 μm) ovoid-ellipsoid basidiospores, and long cylindrico-clavate to flexuous cheilocystidia (Bon 1996, Candusso & Lanzoni 1990, Grilli 1989). In addition, *La. orientiflavus* has obvious yellowish to yellow context in both pileus and stipe, a character not recorded for *La. medioflavoides* (Bon 1996, Candusso & Lanzoni 1990, Grilli 1989).

Leucoagaricus subflavus T.K.A. Kumar & Manim. is a recently described yellowish species from India that is similar to *La. orientiflavus*. However, *La. subflavus* has distinctively smaller basidiomata (10–22 mm in diam.) with whitish stipes, smaller spores (5.5 ± 0.8 × 3 ± 0.2 μm, Q = 1.6–2.3), and a pileus with scattered recurved squamules and a sulcate-striate margin (Kumar & Manimohan 2009).

Several other species with yellowish to yellow basidiomata in the genus *Leucocoprinus* resemble *La. orientiflavus*. *Leucocoprinus birnbaumii* (Corda) Singer has similarly yellow basidiomata but differs in its flocculose squamules and long striations towards the pileal margin, much bigger spores with an obvious germ pore, and lageniform to utriform cheilocystidia (Candusso & Lanzoni 1990).

Leucocoprinus flavus (Beeli) Heinem., originally described from tropical Africa, differs from *La. orientiflavus* in possessing whitish to pale yellow lamellae, whitish context both in the pileus and stipe, and a strong fruity smell. Microscopically, *Lc. flavus* has larger oblong spores (8.3 × 4.3 μm) and variously clavate to sublageniform cheilocystidia that are sometimes apically encrusted with fine crystals (Candusso & Lanzoni 1990, Vizzini & Migliozzi 2007).

Leucocoprinus straminellus (Bagl.) Narducci & Caroti, originally described from Europe, also has yellowish basidiomata and spores without a germ pore. However, the basidiomata of *Lc. straminellus* are more often pale lemon yellow, the spores are broadly ellipsoid to ellipsoid, and the versiform cheilocystidia range from lageniform to clavate cylindrical to cylindrical. In addition, the pileus has long striations towards the margin and is covered by floccose to fine granulose veil remnants (Candusso & Lanzoni 1990).

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